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(54) **Vehicle location**

(57) An automatic vehicle location centre comprises a control centre (2) and a plurality of mobile units (12). Each mobile unit is able to derive a current position signal from external radio signals. A prediction (22) is responsive to this current position signal and to predicted motion of the mobile unit to derive a predicted position signal. The predicted and current position signals are compared and the current position signal is transmitted to the control centre in dependence on the result of the comparison. The control centre (2) has a predictor (10), similar to that in each mobile unit, responsive to the current position signal and to predicted motion of the mobile unit to derive a predicted position. This position data is only transmitted from a mobile unit to the control centre if the predicted position signal differs significantly from the actual position.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

POSITIONING SYSTEM — 20

VELOCITY SIGNAL

12

TRANSMITTER/ RECEIVER — 16

14

MICROPROCESSOR — 18

PREDICTIVE CODER — 22

DATA

TRANSMITTER/ RECEIVER — 4

6

MICROPROCESSOR — 8

PREDICTIVE CODER — 10

2
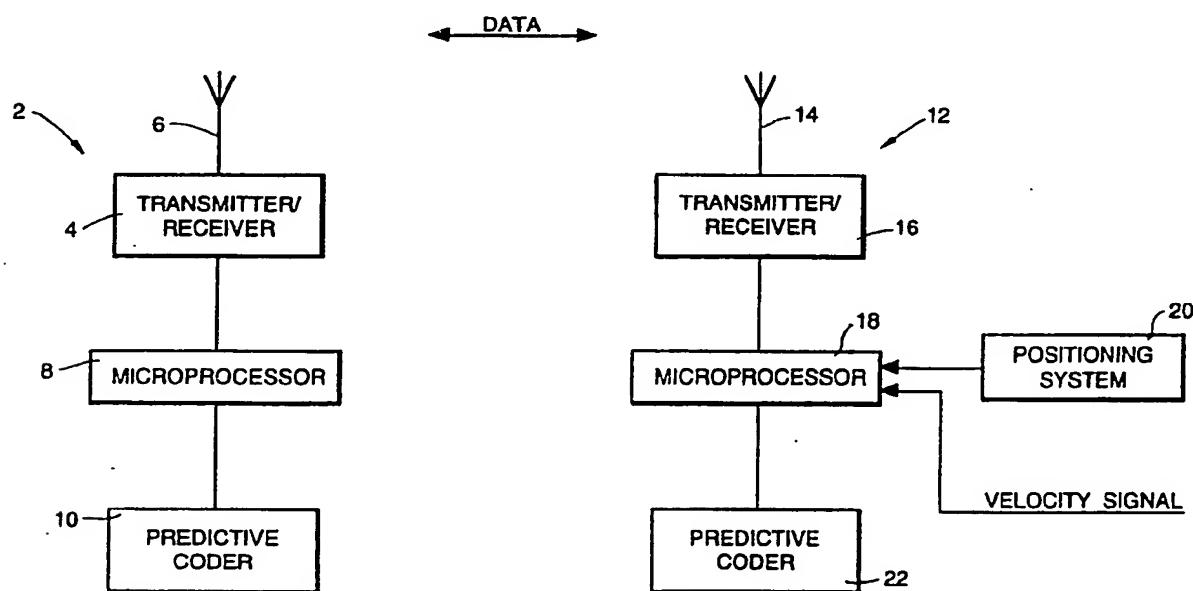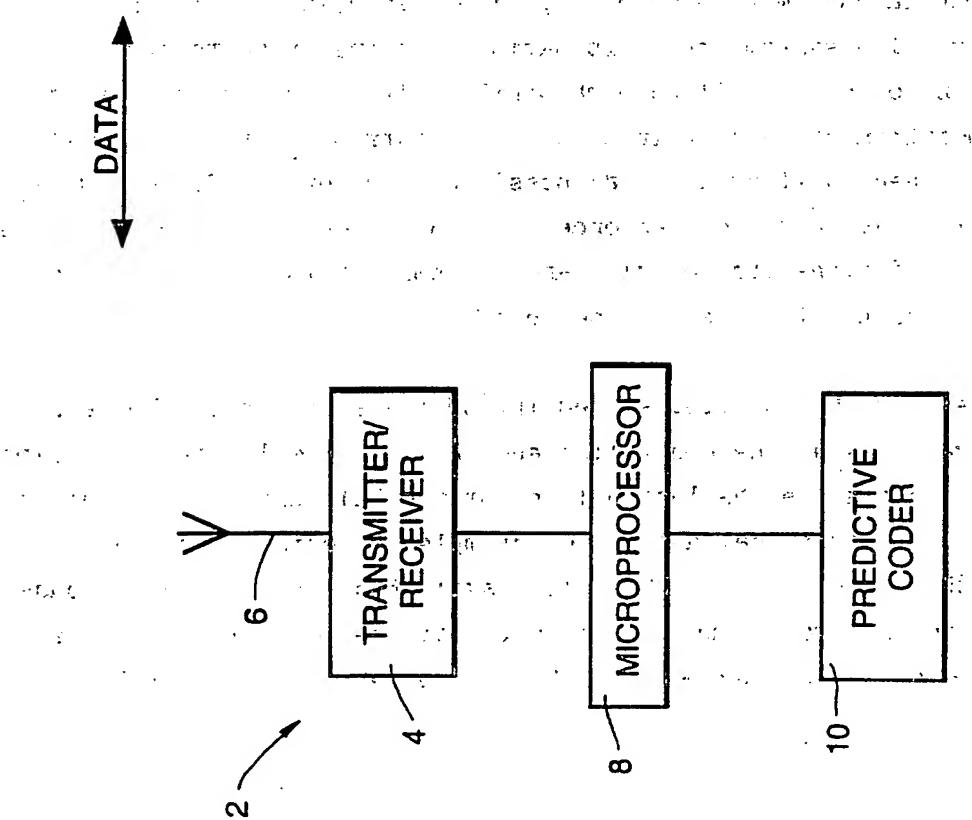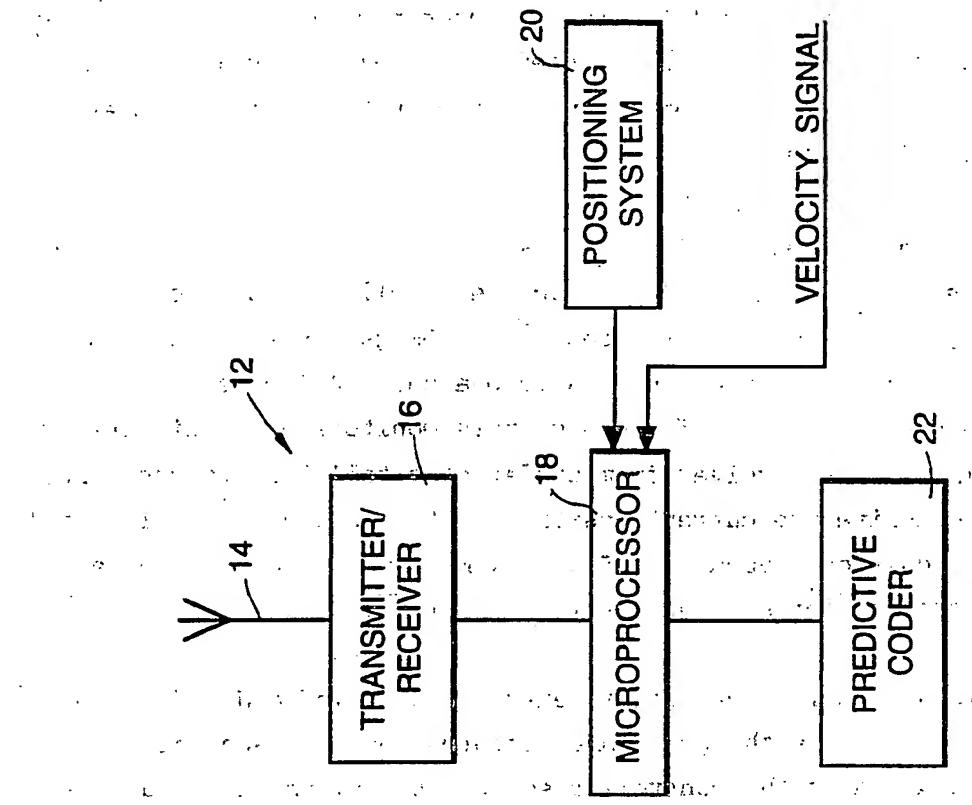
IMPROVEMENTS IN AUTOMATIC VEHICLE LOCATION SYSTEMS

This invention relates to automatic vehicle location systems of the type which may be used, for example, to monitor the locations of each of a plurality of mobile units such as a fleet of vehicles.

A wide range of different basic techniques exist for automatic vehicle location. These include satellite based location systems such as, for example, the Omega system, and also systems which use local radio beacons. A mobile unit operating in one of these systems monitors phase differences in signals received from different satellites and uses these to derive the current position of the mobile unit. Typically a positional accuracy of approximately 100 metres may be obtained for a single derivation of position.

In a system comprising a central controller and a fleet of mobile units the positional information for each unit is required at the controller so that decisions relating to a mobile unit may be made, e.g. job allocation for taxis. In existing systems the information is transmitted to the controller by polling each mobile unit in the system for its position at regular intervals. In current systems the most frequent polling interval possible is generally fixed and is often as infrequent as once every 50 seconds, i.e. each mobile unit derives its position and transmits this information to the controller every 50 seconds.

Using such a polling system introduces an error in the data available at the controller and this error will vary with time elapsed since the last polling of a mobile unit for an update of its positional data. For example, a vehicle cruising at 120 kilometres per hour will travel 1666 metres in 50 seconds. Thus the average positional error at the controller will be slightly over 800 metres. Even if a vehicle is stuck in

traffic at 25 kilometres per hour it will travel 347 metres in 50 seconds thus having an average positional error over the 50 second period of 173.5 metres. This error is, of course, in addition to the error in the originally derived position of the vehicle. Systems which have errors of this magnitude are not able to make best use of mobile units when allocating them to particular jobs.

Another disadvantage of systems which poll mobile units for their positions on a periodic basis is the amount of radio data communications traffic generated. This traffic can easily occupy most of the transmission time on a single radio channel and thus, if a significant number of vehicles are to receive data from the controller, more than one radio channel is required. Using current technology a single mobile radio channel might normally support approximately 100 vehicles without any vehicle location system in operation. A further two radio channels might very well be needed to carry the positional updating information from a vehicle location system provided in each mobile units if regular updates were to be produced once every 50 seconds.

Preferred embodiments of the present invention provide a system for automatic vehicle location which greatly increases the accuracy of positional information available by significantly reducing the errors in positional information which are inherent in a conventional polled vehicle location system. At the same time the amount of radio data communications traffic is significantly reduced.

This is achieved by providing both at the controller and at each mobile unit a predictive coder responsive to a position signal derived at the vehicle and to the vehicle's velocity (speed and direction) at the time that position signal was derived to derive a predicted position for the mobile unit. Thus the controller and each mobile unit have a predicted

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current position signal available to them.

At each mobile unit the predicted position signal derived by
the predictive coder is compared with an actual position
signal derived from the vehicle location unit. If the
difference between the actual position signal and the
predicted position signal exceeds a predetermined limit then
the latest actual position signal and velocity are transmitted
to the controller and used as a new seed input for the
predictive coder. At the same time this latest actual
position signal and velocity are also used as a new seed input
to the predictive coder at the mobile unit.

The invention is defined in its various aspects in the
appended claims to which reference should now be made.

An embodiment of the invention will now be described in
detail, by way of example, with reference to the single figure
which shows a block diagram of circuitry provided at the
controller and at a mobile unit.

In the figure a controller 2 is shown which comprises a
transmitter/receiver 4 coupled to an antenna 6. The
transmitter/receiver is coupled to a microprocessor 8.
Signals for mobile units are generated by the microprocessor 8
and are sent to the units by the transmitter/receiver 4 and
the antenna 6. Signals from the mobile units are received by
the antenna 6 and the transmitter/receiver 4 and are then
supplied to the microprocessor 8.

The microprocessor 8 is also coupled to a predictive coder 10.
This receives a position and a velocity signal from the
microprocessor and, using these, and a linear prediction
technique supplies repeatedly updated predicted position
signals to the microprocessor based on the originally supplied
position and velocity signals and time elapsed since a mobile

unit was last known to be at a particular position.

A mobile unit 12 comprises an antenna 14 coupled to a transmitter receiver 16 which is in turn coupled to a microprocessor 18. Data is sent to and received from the controller 2 via the transmitter receiver 16 and the antenna 14.

The mobile unit also comprises a location system responsive to signals from local beacons or from satellites or from any other form of location system to derive the position of the mobile unit. This is typically derived to within an accuracy of the order of 30 to 300 metres. The location system 20 repeatedly calculates the position of the mobile unit and supplies it to the microprocessors 18. The location system 20 updates the position signal sufficiently quickly for the microprocessor to, effectively, continuously monitor the position.

The microprocessor 18 is also supplied with a velocity signal derived from the speed and direction of the mobile unit.

A second predictive coder 22 is coupled to the microprocessor 18 and this is equivalent to the predictive coder 10 at the controller. Thus when fed with a position and a velocity signal the predictive coder 22 can derive a predicted position for the mobile unit based on a elapsed time since the position signal was generated.

In operation the mobile unit 12 initially derives its position using the location system 20. This is supplied to the microprocessor 18 which transmits it and the velocity signal of the mobile unit to the controller 2 via the transmitter receiver 16 and the antenna 14. At the control centre the position signal and the velocity signal are fed to the predictive coder 10. At the same time the velocity signal and

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position signal are fed to the predictive coder 22 in the
mobile unit 12. The predictive coders 10 and 22 then supply
to their respective microprocessors 8 and 18 predicted
position signals for the mobile unit based on elapsed time
since the position and the velocity signals were generated.
Thus at the controller position data is available based on the
last known position and known velocity of a mobile unit.

At the mobile unit the microprocessor 18 continuously monitors
the predicted position signal derived by the predictive coder
and compares it with the current position signal derived by
the location system 20. Providing the vehicle continues to
move at an average velocity close to that initially fed to the
predictive coder there will be little difference between the
predicted position signal and the actual position signal. If,
however, the mobile unit's velocity changes and it deviates
from the path derived by the predictive coder the actual
position and the predicted position will rapidly diverge.
When the difference between the predicted position and actual
position exceeds a predetermined amount the microprocessor 18
will cause a new actual position signal and velocity signal to
be transmitted to the controller 2 to act as new seeds for the
predictive coder 10. This updated position and velocity will
also be fed to the predictive coder 22 at the mobile unit as
new seeds. The same process will then continue.

Using such a system positional updates are sent from a mobile
unit to the controller only when the mobile unit has deviated
from the predicted path by more than a predetermined amount.
In all other circumstances no positional update needs to be
transmitted to the controller which, of course, has available
to it a predicted position on which it may base any decisions
relating to that mobile unit.

The update message sent from the mobile unit 12 to the
controller 2 will typically be coded into a packet of data of,

for example, 24 user characters. The nature of mobile data communication systems is such that for short messages the message duration is dominated by irreduceible overheads and thus very little more radio air time is needed to send a message of 24 user characters than is needed to send a message purely containing location data. For this reason it is possible to send in the data packet data relating to the position, velocity, time to which the position data refers and, if desired, data relating to rates of change of speed or of direction. Using this additional data more complex predictive coding algorithms can be used to derive the predicted position of a mobile unit more accurately.

Because data messages are only sent from mobile units to the controller 2 when the difference between predicted and actual positions exceeds a predetermined amount the amount of radio traffic between mobile units and the control centre is considerably reduced. For example, a parked vehicle will not send any update to the control centre since its actual position and its predicted position will remain the same. A vehicle cruising on a motorway at a steady speed will only occasionally deviate from its predicted position by an amount in excess of the predetermined threshold (tolerable communications error) and will thus only occasionally require updated positional information to be sent to the controller.

By appropriately programming the microprocessor 18 in a mobile unit the unit can adapt the tolerable communications error in dependence on the actual location of the mobile unit. For example, when the mobile unit is within a dense city centre a low threshold is required, for example, 50 to 100 metres. In less dense areas, e.g. rural areas, it is not necessary to have such an accurate estimation of the position of a mobile unit and a threshold of, for example, 300 to 500 metres would be appropriate.

Thus it can be seen that a vehicle location system which uses the system described above is able to operate with a reduced amount of radio traffic compared to a system which polls mobile units for their locations and furthermore the control centre has available to it a more accurate estimation of the location of a mobile unit than with conventional polled systems.

Claims

1. An automatic vehicle location system comprising a control centre and a plurality of mobile units, each mobile unit comprising means for deriving a current position signal from external radio signals, prediction means responsive to a previously derived current position signal and to predicted motion of the mobile unit to derive a predicted position signal, means for comparing the current position signal with the predicted position signal and means for transmitting the current position signal to the control centre in dependence on the result of the comparison, the control centre comprising prediction means responsive to a received current position signals for a mobile unit and to predicted motion of the mobile unit to derive a predicted position signal for that mobile unit.

2. An automatic vehicle location system according to claim 1 in which each prediction means derives predicted motion for a mobile unit from a velocity signal and from time elapsed since derivation of the current position signal last sent to the control centre.

3. An automatic vehicle location system according to claim 2 in which each prediction means is also responsive to a rate of change of speed signal.

4. An automatic vehicle location system according to claim 2 or 3 in which each prediction means is also responsive to a rate of change of direction signal.

5. An automatic vehicle location system according to claim 2 or 3 in which a new current position signal is transmitted from a mobile unit to the control centre when the result of the comparison is that the difference between current and predicted signals exceeds a predetermined threshold.

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6. An automatic vehicle location system according to claim 5 including means for altering the threshold.

7. An automatic vehicle location system according to claim 6 in which the threshold altering means is responsive to the current position signal to automatically alter the threshold.

8. An automatic vehicle location system according to any preceding claim in which the control centre prediction means is responsive to current position signals from and to predicted motion of each of the plurality of mobile units to derive a predicted position signal for each mobile unit.

9. An automatic vehicle location system according to any preceding claim in which the transmitting means at a mobile unit transmits a new current position signal as a portion of a packet of data set to the control centre.

10. An automatic vehicle location system according to claim 9 in which the packet of data is a 24 character packet.

11. A mobile unit for use in an automatic vehicle location system comprising means for deriving a current position signal, prediction means responsive to a previously derived current position signal and to predicted motion of the mobile unit to derive a predicted postion signal for the mobile unit, means for comparing the current position signal with the predicted position signal, and means for transmitting the current position signal to a control centre in dependence on the result of the comparison.

12. A control centre for use in an automatic vehicle location system comprising prediction means responsive to a current position signal received from a mobile unit and to predicted motion of that mobile unit to derive a predicted

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position signal for that mobile unit.

13.   An automatic vehicle location system substantially as herein described.

14.   A mobile unit for use in an automatic vehicle location system substantially as herein described.

15.   A control centre for use in an automatic vehicle location system substantially as herein described.

Patents Act 1977	Application number
Exe iner's report to the Comptroller under Section 17 (The Search Report) -\\-	GB 9309318.5

Relevant Technical fields	Search Examiner
(i) UK CI (Edition L) H4D (DAB,DSPJ,DSPV,DSPX) (ii) Int CI (Edition 5) G01S	DR E P PLUMMER
Databases (see over) (i) UK Patent Office (ii)	Date of Search 24 JUNE 1993

Documents considered relevant following a search in respect of claims   1-11

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2232316 A (FERRANTI) whole document	
A	GB 2025185 A (SIEMENS) whole document	
A	US 4835537 (MANION) whole document	

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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